PHYSICS

BOOKS - DHANPAT RAI & CO PHYSICS (HINGLISH)

ELECTRIC POTENTIAL AND ELECTRIC FLUX

Example

1. The work done in moving a charge of 3 C between two points is 6J. What is the potential difference between the two points?

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2. Determine the electric potential at the surface of a gold nucleus. The radius is $6 \cdot 6 \times 10^{-15} m$ and the atomic number $Z = 79$. Given charge on proton $1.6 \times 10^{-19} C$.

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3. The electric potential at 0.9m from a point charge is $+50V$. What is the magnitude and sign of the charge ?

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4. A metal wire is bent in a circle of radius 10 cm. It is given a charge $200\mu C$ which is spread on it uniformly. Calculate the electric potential at its center.

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5. The electric field at a point due to a point charge is $20NC^{-1}$ and electric potential at that point is $10JC^{-1}$. Calculate the distance of the point from the charge and the magnitude of the charge.

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6. To what potential we must charge an insulate sphere of radius 14 cm, so that the surface charge density is equal to $2\mu Cm^{-2}$?

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7. A charge of $24\mu C$ is given to a hollow metallic sphere of radius 0.2m. Find the potential

(i) at the surface of sphere

(ii) at a distance of 0.1 cm from the center of sphere.

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8. Twenty seven drops of mercury are charged simultaneously to the same potential of 10V. What will be the potential if all the charge drops are made to combine to form one large drop? Assume the drops to be spherical.

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9. Two points A and B located in diametrically opposite directions of a point charge of +2μC at distances 2.0 m and 1.0 m respectively from it. Determine the potential difference $V_A - V_B$

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10. Two charges $3 \times 10^{-8} C$ and $-2 \times 10^{-8} C$ are located 15 cm apart. At what point on the line joining the two charges is the electric potential zero ? Take the potential at infinity to be zero.

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11. Find the potential at centre of square having charges $2 \times 10^{-9} C, +1 \times 10^{-9} C, -2 \times 10^{-9} C$ and $3 \times 10^{-9} C$ at the four corners. The side of the square is $\sqrt{2} m$.

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12. A cube of side b has a charge q at each of its vertices. Determine the potential and electric field due to this charge array at the center of the cube.

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13. A regular hexagon of side 10 cm has a charge $5\mu C$ at each of its vertices. Calculate the potential at the center of the hexagon.

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14. Two tiny spheres carrying charges $1.5\mu C$ and $2.5\mu C$ are located 30 cm apart. Find the potential

(a) at the mid-point of the line joining the two charges and

(b). At a point 10 cm from this mid-point in a plane normal to the line and passing through the mid-point.

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15. An electric field is set up by two point charges of $+1.2 \times 10^{-8} C$ and $-1.2 \times 10^{-8} C$ as shown in fig. find the potentials at the point A,B, and C

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16. A charge of 8 mC is located at the origin. Calculate the work done in taking a small charge of -2×10^{-9} from a point P(0,0,3cm) to a point Q (0,4cm,0) via a point R(0,6cm,9cm).

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17. Four charges $+q$, $+q$, $-q$, and $-q$ are placed, respectively, at the corners $A, B, C,$ and D of a square of side a, arranged in the given order. E and F are the midpoints of sides BC and CD, respectively, O is the center of square.

The work done in carrying a charge e from O to E is.

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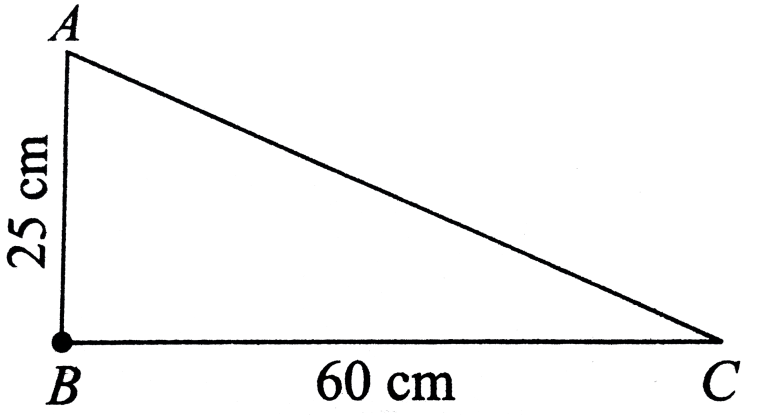
18. ABC is a right - angled triangle, where AB and BC are $25cm$ and $60cm$, respectively. A metal sphere of $2cm$ radius charged to a potential of $9 \times 10^5 V$ is placed at B as in (Fig. 3.133). Find the amount of work done in carrying a positive charge of 1 coulomb from C to A.



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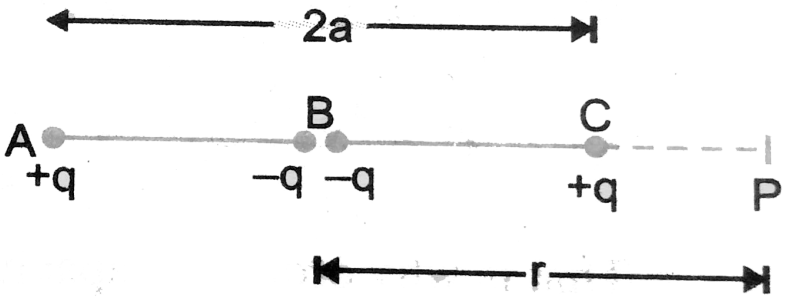
19. Fig shows a charge array known as an 'electric quadrupole'. For a point on the axis of the quadrupole, obtain the dependence of potential on r for $r/a > > 1$, and contract your results with that due to an electric

dipole and an electric monopole (i.e, a single charge).



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20. A short electric dipole has dipole moment of $4 \times 10^{-9} Cm$. Determine the electric potential due to the dipole at a point distant 0.3 m from the centre of the dipole situated on (a) the axial line (b) on equatorial line and (c) on a line making an angle of 60° wth the dipole axis.

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21. Two point charges of $+3\mu C$ are placed 2×10^{-3}m apart from each other. Calculate (i) electric field and electric potential at a distance of 0.6m from the dipole in broad-side-on position (ii) electric field and

electric potential at the same point after rotating the dipole through 90°

.

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22. Find the electric field between two metal plates 3 mm- apart connected to 12 V battery.

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23. Calculate the voltage needed to balance on all drop carrying 10 electrons when located between the plates of a capacitor which are 5 mm apart. Mass of oil drop is $3 \times 10^{-16} kg$(take $g = 10m/s^2$)

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24. A spark passes though air when the potential gradient is 3×10^6 volts per metre what must be the radious of an isoated metal sphere which

can be changed to a potentiial of 3 million voilts before there are sparks in the air?

$$\left[\text{Hint}: E = \frac{Q}{4\pi\varepsilon_0 r^2} \text{ and } V = \frac{Q}{4\pi\varepsilon_o r}, \therefore E = \frac{V}{r}\right]$$

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25. If the potentail in the region of space around the point $(-1m, 2m, 3m)$ is given by $V = \left(10x^2 + 5y^2 - 3z^2\right)$, calculate the three components of electric field at this point.

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26. The electric field outside a charged long straight wire is given by $E = \frac{1000}{r} Vm^{-1}$, and is directed outwards. What is the sign of the charge on the wire ? If two points A and B are situated such that $r_A = 0.2m$ and $r_B = 0.4m$, find the value of $(V_B - V_A)$.

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27. (a). Determine the potential energy of a system containing two charges $7\mu C$ and $-2\mu C$ separated by a distance 18 cm. (b) How much work is needed to separate the two charges infinitely away from each other?

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28. Two positive point charges of $0.2\mu C$ and $0.01\mu C$ are placed 10 cm apart. Calculate the work done in reducing the distance to 5 cm.

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29. Two identical particles, each having a charge of $2.0 \times 10^{-4} C$ and then released. What would be the speeds of the particles when the separtion becomes large?

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30. Two particles have equal masses of 5.0 g each and opposite charges of $+4.0 \times 10^{-5} C$. They are released from rest with a separation of 1.0 m between them. Find the speeds of the particles when the separation is reducced to 50 cm.

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31. If one of the two electrons of a hydrogen molecule is removed, we get a hydrogen molecule ion $\left(H_2^+\right)$. In the ground state of H_2^+, the two protons are separated roughly by 1.5Å and electron is roughly 1Å from each proton. Determine the potential energy of the system. Specify your choice of zero of potential energy.

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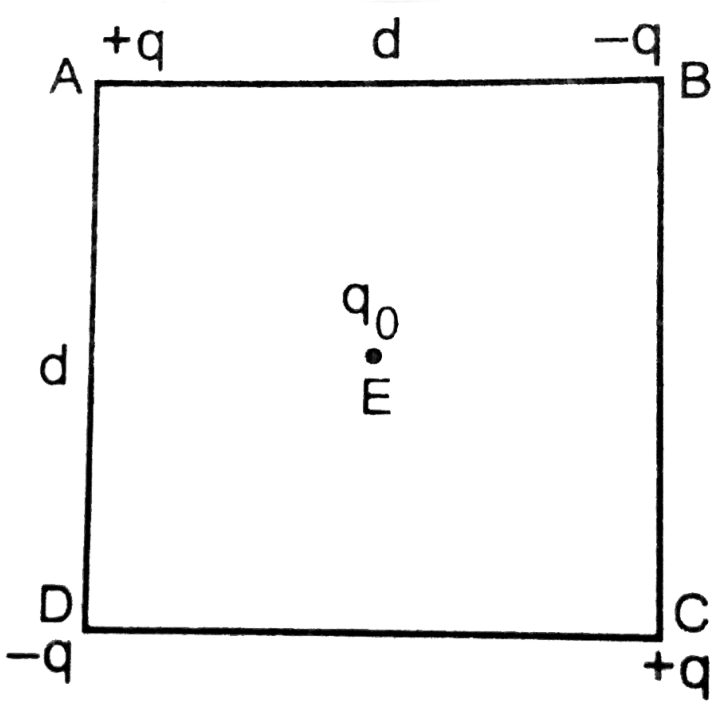
32. Four charges are arranged at the corners of a square ABCD of side d, as shown in Fig. Find the work required to put together this arrangement (b) A charge q_0 brought to the center E of the square, the four charges

being held fixed at the corners . How much extra work in needed to do this ?



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33. Two charges $q_1 = +2 \times 10^{-8} C$ and $q_3 = -0.4 \times 10^{-8} C$ are placed 60cm apart, as shown in fig. A third charge $q_3 = +0.2 \times 10^{-8} C$ is moved along the arc of a circle of radius 80 cm from C to D. Compute the percentage change in the energy of the system.

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34. An electric dipole of length 2 cm is placed with its axis making an angle of 60° to a uniform electric field of $10^5 NC^{-1}$ if its experiences a torque is $8\sqrt{3}$Nm, calculate the

(i). Magnitude of the charge on the dipole and

(ii). potential energy of the dipole.

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35. An electric dipole consists of two opposite charges each of magnitude $1\mu C$ separated by $2cm$. The dipole is placed in an external uniform field of $10^5 NC^{-1}$ intensity. Find the

a. maximum torque exterted by the field on the dipole, and

b. work done in roating the dipole through 180° starting from the position $\theta = 0^\circ$.

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36. The electric dipoles of moments p_1 and p_2 are in a straight line. Show that the potential energy of each in the presence of the other is $-\frac{1}{2\pi\varepsilon_0}\cdot\frac{p_1p_2}{r^3}$, where r is the distance between the dipoles. (Assume r to be much greater than the length of the dipole).

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37. A molecule of a substance has a permanent electric dipole moment of magnitude 10^{-29}C m. A mole of this substance is polarized at low temperature by appling a strong elecrostatic field of magnitude $10^6 Vm^{-1}$. The direction of the field is suddenly changed by an angle of 60°. Estimate the heat released by the substance in aligning its dipole along the new direction of the field. For simplicity, assume $100\,\%$ polarisation of sample.

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38. In a region of space, the electric field is given by $\vec{E} = 8\hat{i} + 4\hat{j} + 3\hat{k}$. The electric flux through a surface of area 100 units in the xy plane is

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39. Consider a uniform electric field $E = 3 \times 10^3 \hat{i} N/C$. (a) What is the flux of this field through a square of 10 cm on a side whose plane is parallel to the yz plane ? (b) What is the flux through the same square if the normal to its plane makes a 60° angle with the x-axis ?

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40. A circular plane sheet of radius 10 cm is placed in a uniform electric field of $5 \times 10^5 NC^{-1}$, making an angle of 60° with the field. Calculate electric flux through the sheet.

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41. A positive charge of $17.7\mu C$ is placed at the centre of a hollow sphere of radius $0.5m$. Calculate the flux density through the surface of the sphere.

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42. Five thousand lines of force enter a certain volume of space and three thousand lines emerge from it. What is the total charge in coulomb within this volume ?

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43. A point charge causes an electric flux of $-1.0 \times 10^3 Nm^2/C$ to pass through a spherical Gaussian surface of 10.0 cm radius centred on the charge. (a) If the radius of the Gaussian surface were doubled, how much flux would pass through the surface ? (b) What is the is the value of the point charge ?

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44. Careful measurement of the electric field at the surface of a black box indicates that the net outward flux through the surface of the box is $8.0 \times 10^3 Nm^2/C$ (a) what is the net charge inside the box ? (b) If the net outward flux through the surface of the box were zero, could you conclude that there were no charges inside the box ? Why or why not?

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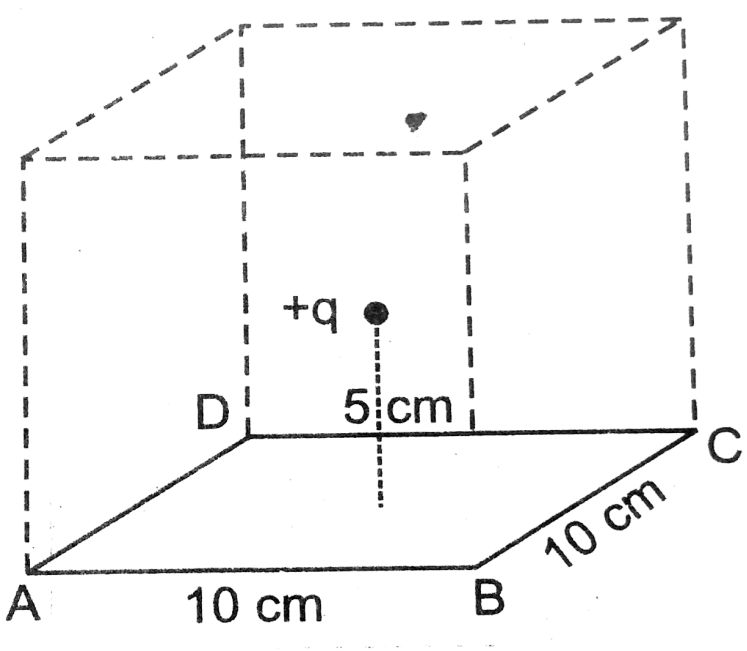
45. A point charge $+10\mu C$ is at distance of 5cm directly above the center of a square of side 10 cm as shown in Fig. What is the magnitude of the electric flux through the square ? (Hint. Think of the square of the square

as one face of a cube with edge 10 cm)



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46. A uniformly charged conducting sphere of 2.4m diameter has a surface density of $80.0\mu C/m^2$. (a) Find the charge on the sphere (b) What is the total electric flux leaving the surface of the sphere ?

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47. An electric charge is placed at the centre of a cube of side a.The electric flux

(i) through one of its faces $\frac{q}{6 \in_0}$

through one of its faces $\frac{q}{3 \in_0}$

(iii) through all of its faces $\frac{q}{\in_0}$

(iv) through one of its faces $\frac{q}{2 \in_0}$

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48. A sphere S_1 of radius r_1 encloses a total charge Q. If there is another concentric sphere S_2 of radius $r_2 (> r_1)$ and there be no additional charges between S_1 and S_2 find the ratio of electric flux through S_1 and S_2,

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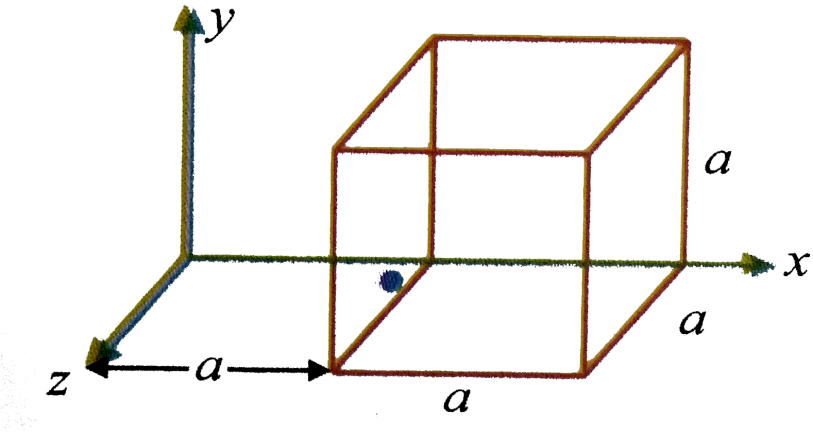
49. The electric components in the figure are $E_x = \alpha x^{1/2}, E_y = 0, E_z = 0$ where $\alpha = 800 N/m^2$ if $a = 0.1m$ is the

side of cube then the charge with in the cube is



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50. A uniform electric field exists in space. Find the flux of this field through a cylindrical surface with the axis parallel to the field.

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51. A charge q_0 is distributed uniformly on a ring of radius R. A sphere of equal radius R constructed with its centre on the circumference of the ring. Find the electric flux through the surface of the sphere.

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52. A cylinder of large length carries a charge of $2 \times 10^{-8} Cm^{-1}$ find the electric field at a distance of 0.2 m from it.

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53. An infinite line charge produces a field of $9 \times 10^{-4} N \quad C^{-1}$ at a distance of 2 cm. calculate the linear charge density.

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54. If the field near the earth's surface is 300V m^{-1} directed downwards , what is the surface density of change on the surface of the earth?

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55. Two large, thin metal plates are parallel and close to each other. On their inner faces, the plates have surface charge densities of opposite signs and of magnitude $19 \times 10^{-22} Cm^{-2}$.

What is E (a) to the left of the plates (b) to the right of the plates (c) between the plates ?

Here, $\sigma = 19 \times 10^{-22} Cm^{-2}$

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56. An infinite plane sheet of charge density $10^{-8} Cm^{-2}$ is held in air. In this situation how far apart are two equipotenitial surfaces, whose p.d is 5 V ?

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57. A conducting sphere fo radius 10 cm has an unknown charge. If the electric field 20 cm from the center of the sphere is $1.5 \times 10^3 N/C$ and points radilly inwards, what is the net charge on the sphere ?

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58. A spherical conductor of radius 12 cm has a charge of $1.6 \times 10^{-7} C$ distributed uniformly on its surface. What is the electric field (a) inside the sphere (b) just outside the sphere (c) at a point 18 cm from the center of the sphere ?

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59. In a van de Graaff type generator, a spherical metal shell is to be a $15 \times 10^{5} V$ electrode. The dielectric strength of the gas surrounding the electrode is $5 \times 10^{7} V m^{-1}$. What is the minimum radius of the spherical shell required?

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Problem

1. The electric potential V at any point x, y, z (all in meters) in space is given by $V = 4x^2$ volts. The electric field at the point (1m, 0, 2m) is.....V/m.

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2. A radioactive source, in the form of a metallic sphere of radius $10^{-2}m$ emits $\beta -$ particles at the rate of 5×10^{10} particles per second. The source is electrically insulated. How long will it take for its potential to be raised by $2V$, assuming that $40\,\%$ of the emitted $\beta -$ particles escape the source.

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3. An infinite number of charges each equal to q, are placed along the X-axis at $x = 1, x = 2, x = 4, x = 8$,..... and so on.

(i) find the electric field at a point $x = 0$ due to this set up of charges.

(ii) What will be the electric field if the above setup, the consecutive charges have opposite signs.

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4. A charge Q is distributed over two concentric hollow spheres of radii r and $R(>r)$ such that the surface charge densities are equal. Find the potential at the common centre.

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5. Three concentric spherical metallic shells A, B and C of radii a, b and c (a lt b ltc) have surface charge densities σ, $-\sigma$ and σ respectively.

`(i) Find the potential of the three shells A, B and C.

(ii) If the shells A and C are at the same potential, obtain the relation between the radii a, b and c.

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6. Two identical thin ring, each of radius R meters, are coaxially placed a distance R metres apart. If Q_1 coulomb, and Q_2 coulomb, are repectively the charges uniformly spread on the two rings, the work done in moving a charge q from the centre of one ring to that of the other is

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7. Two circular loops of radii 0.05 and $0.09m$, respectively, are put such that their axes coincide and their centers are $0.12m$ apart. A charge of $10^{-6}C$ is spread uniformly on each loop. Find the potential difference between the centers of the loops.

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8. A drop of water of mass 18×10^{-3} g falls away from the bottom of a charged conducting sphere of radius 20 cm, carrying with it a charge of $10^{-9}C$ and leaving on the sphere a uniformly distributed charge of

$2.5 \times 10^{-6} C$. What is the speed of the drop after it has fallen 30 cm?

$(4\pi\varepsilon_0)^{-1} = 9 \times 10^9 JmC^{-2}$

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9. Three charges 0.1 coulomb each are placed on the corners of an equilateral triangle of side $1m$. If the energy is supplied to this system at the rate of $1kW$ how much time would be required to move one to the charges on to the midpoint of the line joining the two ?

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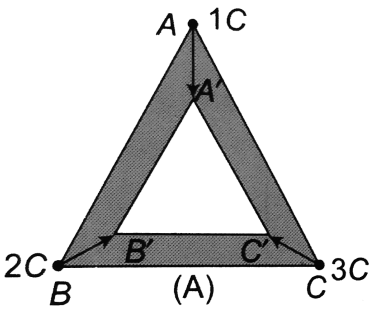
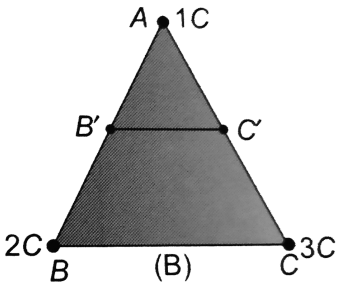
10. Three point charges $1C, 2C$ and $3C$ are placed at the corners of an equilaternal triangle of side $1m$. The work required to move these charges to the corners of a smaller equilaternal triangle of side $0.5m$ in

two differenct ways as in fig. (A) and fig. (B) are W_a and W_b then:





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11. Three point charges q, 2q and 8q are to be placed on a

. 9cm long straight line. Find the

. positions where the charges shouldbe placed such that the potential energy

. of this sysrem is minimum. In this situation, what is the

. electric field at the charge q due to the other two charges?

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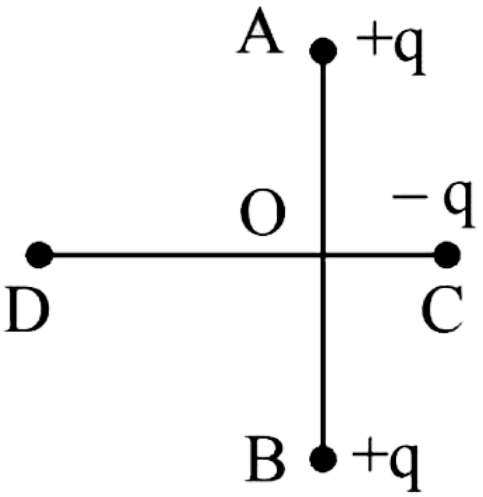
12. Two fixed, equal, positive charges, each of magnitude 5×10^{-5} coul are located at points A and B separated by a distance of 6m. An equal and opposite charge moves towards them along the line COD, the perpendicular bisector of the line AB.

The moving charge, when it reaches the point C at a distance of 4m from O, has a kinetic energy of 4 joules. Calculate the distance of the farthest point D which the negative charge will reach before returning towards C.



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13. Three charges each of value q are placed at the corners of an equilateral triangle. A fourth charge Q is placed at the center of the triangle.

a. Find the net force on charge q.

b. If $Q = -q$, will the charges at the corners move toward the center or fly away from it ?

c. For what value of Q and O will the charges remain stationary ?

d. In situation (c), how much work is done in removing the charges to infinity ?

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14. (i). A charge of Q coulomb is uniformly distributed over a spherical volume of radius R metre Obtain an expression for the energy of the system.

(ii). What will be the corresponding expression for the energy needed to completely diassemble the planet earth against the gravitational pull amongst its constituent particles? Assume the earth to be a sphere of

uniform mass density. calculate the energy, given that the product of the mass and the radius of the earth to be $2.5 \times 10^{31} kg - m$

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15. A proton moves with a speed of $0.75 \times 10^{5} ms^{-1}$ directly towards a free proton originally at rest. Find the distance of closest approach of the two protons. Mass of proton $= 1.66 \times 10^{-27} kg$.

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Problems For Self Practive

1. In a circuit, 10 C of charge is passed through a battery

. in a given time. The plates of the battery are maintained

. at a potential difference of 12 V. How much work is done

. by the battery?.

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2. (a) Calculate the potential at a point P due to a charge of $4 \times 10^{-7} C$ located 9 cm away.

(b) Hence obtain the work done in bringing a charge of $2 \times 10^{-9} C$ from infinity to the point P. Does the answer depend on the path along which the charge is brought ?

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3. What must be te magnitud eof an isolated positive charge so as to produce an electric potential of $3 \times 10^{5} V$ at a distance of 3 m from it?

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4. The electric field at a point due to a point is $10 NC^{-1}$ and the electric potential at that point is $15 JC^{-1}$ Calculate the distance of the point from the charge and the magnitude of the charge.

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5. Charge of $12\mu C$ is given toa hollow metallic sphere of radius 0.1 m. find the potential at (i) the surface of the sphere (ii) the centre of the sphere.

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6. A hollow metal sphere is charged with $0.4\mu C$ of charge and has a radius of 0.1 find the potential (i) at the surface (ii) inside the sphere (iii) at a distance of 0.6m from the centre. The sphere is placed in air.

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7. Compute the electric potential at the surface of the nucleus of a silver atom. The radius of the nucleus is 3.4×10^{-14}m and the atomic number of silver is 47.

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8. Eight charged drops of water, each of radius 1 m and having a charge of 10^{-10} coulomb, combine to form a bigger drop. Determine the potential of the bigger drop.

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9. Two point charges of $+10\mu C$ and $+20\mu C$ are placed in free space 2 cm apart. Find the electric potential at the middle point of the line joining the two charges.

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10. Two point charges one of $+100\mu C$ and another of $-400\mu C$, are kept 30 cm apart. Find the point of zero potential on the line joining the two charges.

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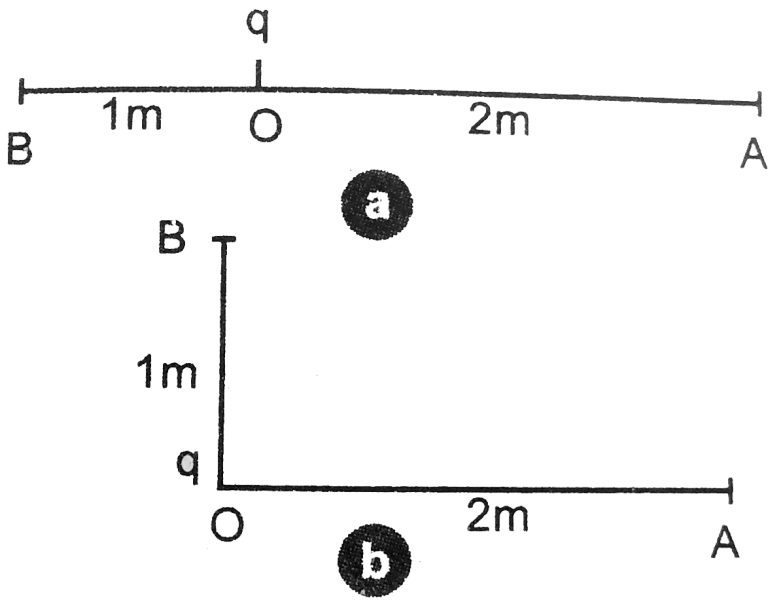
11. A charge $q = +1\mu C$ is held at O between two points A and B such that $AO = 2m$ and $BO = 1m$, Fig . Calculate the value of potential differences $(V_A - V_B)$. What will be the value of potential differences $(V_A - V_B)$ if position of B is charged as shown in Fig ?



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12. Two small sphres of radius 'a' each carryig charges $+q$ and $-q$ and placed at points A and B, distance 'd' apart. Calculate the potential difference point A and B.

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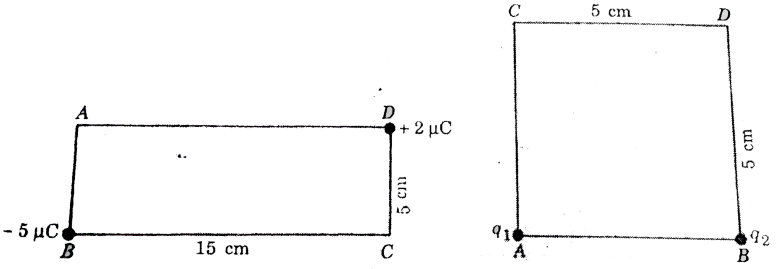
13. The sides of rectangle ABCD are 15 cm and 5 cm, as shown in figure. Point cahrges of $-5\mu C$ and $+2\mu C$ are placed at the vertices B and D respectively. Calculate electric potential at the vertices A and C. Also calculate the work done in carrying a charge of $3\mu C$ from A to C.



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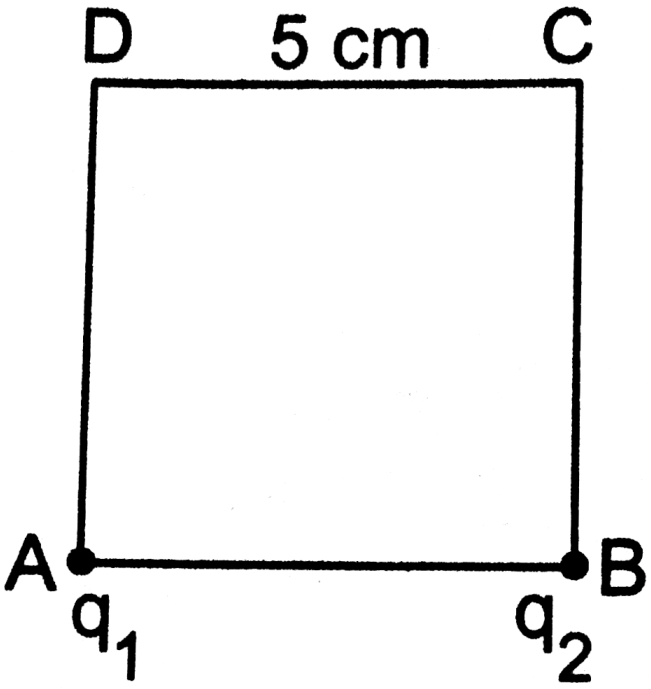
14. charges $2.0 \times 10^{-6}C$ and $1.0 \times 10^{-6}C$ are placed at. corners A and B of a squae of side 5.0cm as shown in. figure .how much work will be done against. the electric field in moving a charge of 1.0×10^{-6} C from. C to

D?.



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15. What is the potential at the centre of a square of each side 1.0 meter, when four charges $+1 \times 10^{-8}C,\ -2 \times 10^{-8}C,\ +3 \times 10^{-8}C$ and $+2 \times 10^{-8}C$ are placed at the four corners of the square.

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16. Charges of $+1.0 \times 10^{-11} C, -2.0 \times 10^{-11}, +1.0 \times 10^{-11} C$ are placed respectively at the corners B, C and D of a rectangle ABCD. Determine the potential at the corner A. given AB=4cm and BC=3cm

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17. ABCD is a square of side $0.2m$. Charges of $2 \times 10^{-9} C, 4 \times 10^{-9} C$ and $8 \times 10^{-9} C$ are placed at the corners A, B and C respectively. Calculate work required to transfer a charge of $2 \times 10^{-9} C$ from corner D to centre of the square.

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18. charges of $20nC$ each are placed at the corners A and B of a square ABCD of side $\sqrt{8} cm$ and charges of $-10nC$ at the corners C and D. find the potential at the centre of the square.

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19. Positive charges of 6,12 and 24 nC are placed at the thre vertices of a square. What charge must be placed at fourth vertex so that total potential at the centre of the square is zero?

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20. Two equal charges, $2.0 \times 10^{-7} C$ each, are held fixed at a separation of 20cm. A third charge of equal magnitude is placed midway between the two both the charges. How much work is done by the electric field during the process?

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21. The electric potential at a point distant 0.1m from the middle of a short electric dipole on a line inclined at an angle of 60° with the dipole axis is 900V. Calculate the dipole moment.

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22. A uniform electric field of $20NC^{-1}$ exists in the vertically downward direction. Determine the increase in the electric potential as one goes up through a height of 50 cm.

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23. A uniform electric field of $30NC^{-1}$ exists along the X-axis calculate the potential difference $V_B - V_A$ between the points A (4m,2m) and B(10m,5m).

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24. An electric field $\overrightarrow{E} = \overrightarrow{i20 + j}\,30NC^{-1}$ exists in the space. If the potential at the origin is taken to be zero find the potential at (2m, 2m).

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25. The electric field in a region is given by $\vec{E} = \left(\frac{A}{x^3}\right)\vec{I}$. Write a suitable SI unit for A. Write an experssion for. the potential in the region assuming the potential at. infinity to be zero.

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26. Calculate the electric potential energy of an electron-proton system of an atom . The radius of the orbit of the electron is 21.16×10^{-11}m the charge on electron is $1.6 \times 10^{-19}C$.

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27. Two protons in a U^{238} nucleus are $6.0 \times 10^{-15}m$ apart. What is their mutual electric potential energy?

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28. Two positive point charges of $12\mu C$ and $8\mu C$ are $10cm$ apart. The work done in bringing then $4cm$ closer is

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29. Charges of $+4\mu C, -6\mu C$ and $-16\mu C$ are placed in air at the corners of an equilateral triangle of side 10. find the potential energy of the system. $-0.72J$

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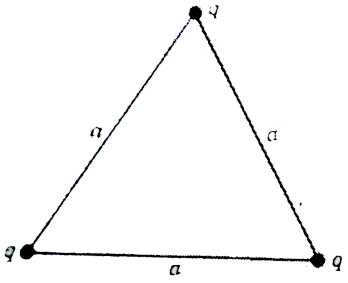
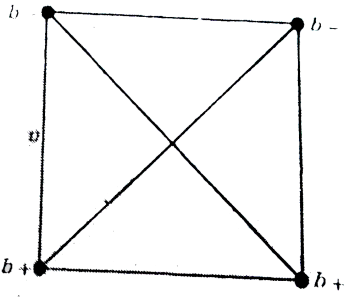
30.





Three point charges are arranged as show in figure. What is their mutual potential energy? Take $q = 1.0 \times 10^{-4}C$ and $a = 10cm$.

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31. Determine potential energy of the charge configuration shown in figure.

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32. Three charges $+q, 2q \text{ and } -4q$ are placed on the three vertices of an equilateral triangle of each side $0 \cdot 1m$. Calculate electrostatic potential energy of the system, take $q = 10^{-7}C$

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33. Three charges $+q, +q \text{ and } -q$ are located at the corners of an equilaterial triangle of side a. Calculate potential energy of the system.

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34. Three particles, each having a charge of $10\mu C$, are. placed at the vertices of an equilateral triabngle of side. 10 cm. Find the work done by a person in pulling them. apart to infinite separtions.

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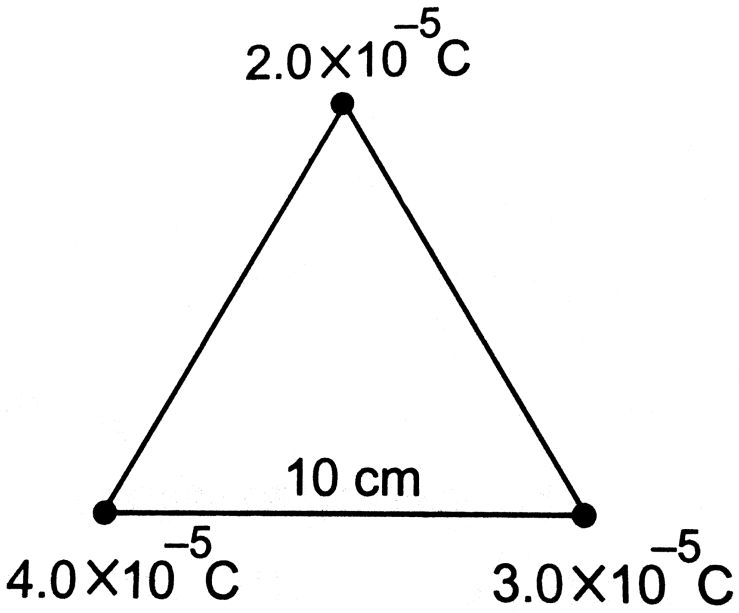
35. How much work has to be done in assembling three charged particles at the vertices of an equilateral triangle as shown in figure



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36. What is the electrostatic potential energy of the charge configuration shown in figure. Take $q_1 = +1.0 \times 10^{-8} C, q_2 = -2.0 \times 10^{-8} C, q_3 = +3.0 \times 10^{-8} C, q_4 = +$ metre.

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37. Three charges -q, +q and -q are placed along a st. line at equal distance , say a. Calculated the potential energy of this system of charges (i) when +q charge is in the middle and (ii) when this charge is at one end.

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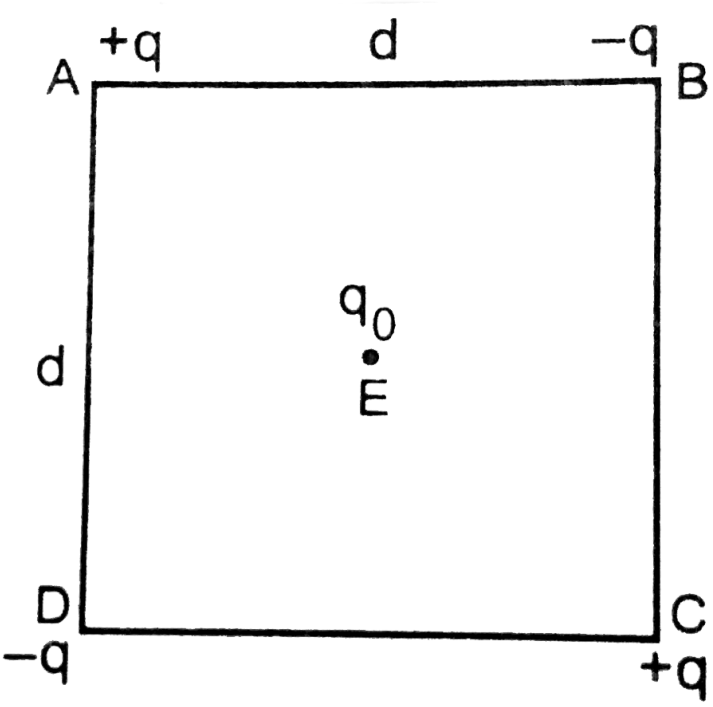
38. Four charges are arranged at the corners of a square ABCD of side d, as shown in Fig. Find the work required to put together this arrangement (b) A charge q_0 brought to the center E of the square, the four charges being held fixed at the corners . How much extra work in needed to do

this ?



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39. Two electrons each moving with a velocity of $10^6 ms^{-1}$ are released towards eachother. What will be the closest distance of approach between them ?

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40. Two identical particles of mass m carry a charge Q, each. Initially one is at rest on a smooth horizontal plane and the other is projected along the plane directly towards first particle from a large distance with speed v. The closest distance of approach be .

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41. An electric dipole consists of two opposite charges of magnitude $2 \times 10^{-6} C$, separated by 4.0 cm. the dipole is placed in an external field of $10^5 NC^{-1}$ find the work done by an external agent to turn the dipole thorugh 180°

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42. A certain dipole has opposite charges of 2×10^{-5} separated by a distance of 0.2mm. It is placed in a uniform electric field of $10^3 Vm^{-1}$. (i) find the torque, the field exerts on the dipole when the dipole is at 60° with respect to the field. (ii) find the work, it would take to rotate the

dipole to this position starting with the dipole aligned parallel to the field

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43. Two charges $+3.2 \times 10^{-19}$ and $-3.2 \times 10^{-19} C$ placed at $2.4A$ apart from an electric dipole. It is placed in a uniform electric field of intensity $4 \times 10^{5} \text{volt} / m$. The electric dipole moment is

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44. A uniform electric field of $200 NC^{-1}$ exists in space in the X-direction. Calculate the flux of this field through a plane square area of edge 10 cm placed in the Y-Z

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45. A circular plane sheet of radius 10 cm is placed in a uniform electric field of $5 \times 10^5 NC^{-1}$, making an angle of 60° with the field. Calculate electric flux through the sheet.

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46. Calculate the total charge enclosed by a closed surface, the number of lines of force emerging from it is 15000 and that entering it is 5000.

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47. A spherical Gaussian surface encloses a charge of $8.85 \times 10^{-8} C$ (i) Calculate the electric flux passing through the surface (ii) If the radius of Gaussian surface is doubled, how would the flux change ?

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48. An arbitrary surface encloses a dipole. What is the electric flux through this surface ?

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49. A point charge of 10^{-7}C is situated at the centre of a cube of side 1m. Calculate the electric flux through its surface.

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50. Find the electric flux through each face of a hollow cube of side 10 cm, if a charge of $8.85\mu C$ is placed at its centre.

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51. Consider a uniform electric field $E = 3 \times 10^3 \hat{i} N/C$. (a) What is the flux of this field through a square of 10 cm on a side whose plane is

parallel to the yz plane ? (b) What is the flux through the same square if the normal to its plane makes a 60° angle with the x-axis ?

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52. The electric field in a region is given by $\vec{E} = \frac{3}{5}E_0\vec{i} + \frac{4}{5}E_0\vec{j}$ with $E_0 = 2.0 \times 10^3 NC^{-1}$. Find the flux of this field through a recatngular surface of area $0.2m^2$ parallel to the y-z plane.

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53. A charge q is situated at the centre of an imaginary hemispherical surface, as shown in figure. Using gauss's theorem and symmetry considerations, determine the electric flux due to this charge through the hemisphere surface.

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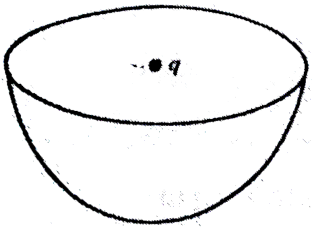

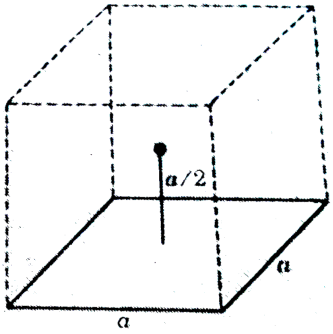

54.

A point charge q is placed at a distnace a/2 directly above the centre of a square of side a, as shown figure. Find the magnitude of the electric flux through the square.

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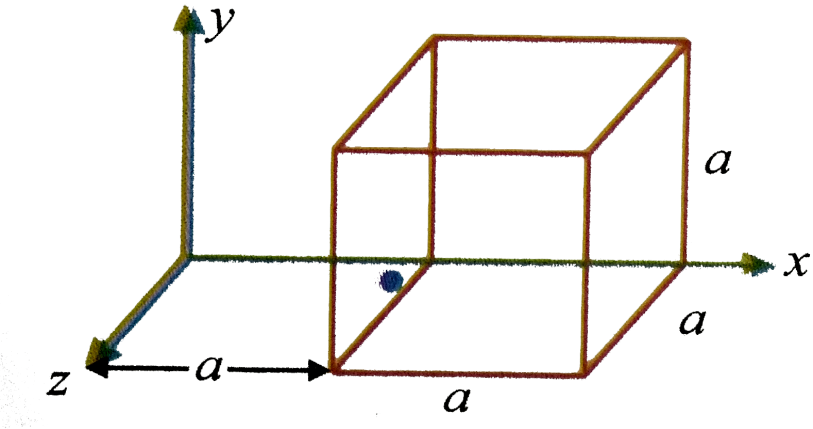
55. The electric components in the figure are $E_x = \alpha x^{1/2}, E_y = 0, E_z = 0$ where $\alpha = 800N/m^2$ if $a = 0.1m$ is the

side of cube then the charge with in the cube is



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56. The electric field In a region is given gy $\vec{E} = \frac{E_0 x}{b}\hat{i}$. Find the charge contained in the cubical volume bounded by the surfaces x=0, x=a, y=0, y=a,z=0 and z=a. take $E_0 = 5 \times 10^3 NC^{-1}$, $a = 1cm$ and $b = 2cm$.

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57. An infinitely long wire is stretched horizontally 4 metre above the surface of the earth. It carries a charge $1\mu C$ per cm of its length.

Calculate its electric field at a point on the earth's surface vertically below the wire.

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58. Two large metal plates each of area $1m^2$ are placed facing each other at a distance of 5 cm and carry equal and opposite charges on their faces. If the electric filed between the plates is $1000NC^{-1}$, find the charge on each plate.

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59. A charge of 1500 μC is distributed uniformly over a very large sheet of surface area $300m^2$. Calculate the electric field at a distance of 25 cm.

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60. A uniformly charged sphere has a total charge of $300\mu C$ and radius of 8 cm. find the electric field (i) at a point 16 cm from the centre of the sphere (ii) at a point on the surface of the sphere (iii) at a point inside the sphere.

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61. A charged particle having a charge of $-2.0 \times 10^{-6} C$ is placed close to a non-conducting plate having a surface charge density $4.0 \times 10^{-6} Cm^{-2}$. Find the force of attraction between the particle and the plate.

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